Fire Tests on Wood Pallets

Sponsored by

HSB Industrial Risk Insurers
and
Chep USA

Test Report

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Prepared By

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Executive Summary

This report describes two series of tests conducted on wood pallets. The first series evaluated the effectiveness of sprinkler protection on stacks of idle pallets. The second series evaluated the commodity classification of two types of wood pallets with Class II commodity.

Two types of pallets were tested in this test series. The first type was identified as 2-way hardwood oak pallets. The second type was identified as 4-way southern yellow pine pallets.

The idle pallet series consisted of six fire tests conducted with stacks of wood pallets. The purpose of the tests was to evaluate the effectiveness of sprinklers to control idle pallet fires in accordance with NFPA 231 1995 edition Section 4 Table 4-4.1.2.

The idle pallet tests consisted of placing an array of wood pallet stacks below a 30 ft. ceiling equipped with a sprinkler system. The pallets were ignited in the center of the array and the effectiveness of the sprinkler system was observed. Measurements during the tests included: (i) number of operated sprinklers, (ii) steel beam temperatures above the fire, and (iii) radiant heat fluxes. The flame spread through the pallet array was also recorded.

Two storage arrangements were used in this investigation as shown in Figure 1. One tests was conducted with a 2x2 array. Five tests were conducted with a 2x3 array. The 2x2 array was used only once because the array was not large enough to evaluate flame spread.

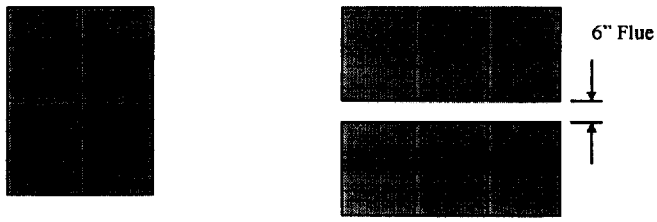


Figure 1. Plan View of Test Layout

A summary of the idle pallet results is provided below.

Table 1. Idle Storage Results

Test	Array	Sprinkler	Activated Sprinklers	Maximum Steel Temp. [1] (°C)	Max Heat Flux (kW/m²)	Fire spread To end of array
1	2-way, 2x2, 8ft.	286°F, K8, 0.3 gpm/ft²	7	170	[3]	Yes
2	4-way, 2x3, 8ft.	286°F, K8 0.3 gpm/ft²	40 [2]	725 [2]	21 [2]	Yes
3	4-way, 2x3, 12 ft.	286°F, K8 0.6 gpm/ft²	10	658	19	Yes
4	2-way, 2x3, 8 ft.	286°F, K8 0.3 gpm/ft²	8	148	12	No
5	2-way, 2x3, 12 ft.	286°F, K8 0.6 gpm/ft²	7	157	14	No
6	4-way, 2x3, 12 ft.	165°F, K11 0.6 gpm/ft²	13	94	9	Yes

Note:
1. The maximum steel temperature is an average of the five temperatures measured on the beam.
2. The fire was still growing when the test was manually terminated.
3. The heat flux was not measured in test 1.

In the second series, commodity classification tests were conducted with the two types of wooden pallets and Class II commodity. The commodity classification tests were evaluated in accordance with the SP protocol.

The test results for the commodity classification test series is shown below.

Table 2. Commodity Classification Results

Sample	Rank	Commodity Class
Class II on 2-way Pallet	1.7	Class II
Class II on 4-way Pallet	2.1	Class II

Contents

FIGURES

Tables

Abbreviations

°C	Centigrade
CFM	cubic feet per minute
ft.	Foot
°F	Fahrenheit
gpm	gallons per minute
in.	Inch
IRI	Industrial Risk Insurers
kW	kilowatts
MW	megawatts
m	meter
RTI	response time index
UL	Underwriters Laboratories, Inc.
'	feet
"	inches

1. INTRODUCTION

This Report describes a Special Service Investigation conducted for HSB Industrial Risk Insurers, Chep USA and Underwriters Laboratories.

The sole purpose of this investigation was to develop information and data on the flammability of the wood pallets by means of fire tests. The information obtained by this investigation is to be used by HSB Industrial Risk Insurers.

In no event shall UL be responsible to anyone for whatever use or nonuse is made of the information contained in this Report and in no event shall UL, its employees or its agents incur any obligations or liability for damages, including, but not limited to, consequential damage, arising out of or in connection with the use or inability to use the information contained in this Report.

Information conveyed by this Report applies only to the specimens actually involved in these tests. UL has not established a factory Follow Up Service Program to determine the conformance of subsequently produced material nor has any provision been established to apply any registered mark of UL to such material.

The issuance of this Report in no way implies Listing, Classification or Recognition by UL and does not authorize the use of UL Listing, Classification or Recognition Marks or other reference to UL on or in connection with the product or system.

2. TEST FACILITY

The fire tests were conducted in Underwriters Laboratories large scale fire test facility located in Northbrook Illinois. The large-scale fire test building used for this investigation houses four fire test areas which are used to develop data on the fire growth and fire suppression characteristics of commodities, as well as the fire suppression characteristics of automatic water sprinkler systems. A schematic of the test facility is shown in Figure 1.

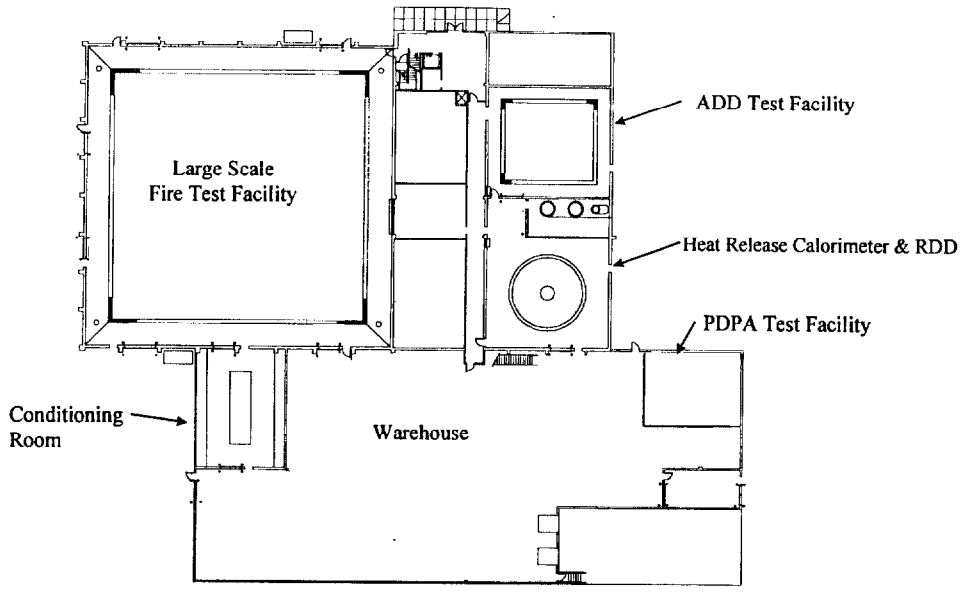


Figure 1. Test Facility

The exhaust flow rate in the fire test facility can be adjusted to provide a maximum of 60,000 SCFM. Four, inlet ducts provide make up air in the test facility and are located at the walls 10 ft. above the test floor to minimize any induced drafts during the fire tests.

All products of combustion from the tests are contained within the test facility and processed through a state of the art regenerative thermal oxidizing system.

2.1 Large Scale Facility

The idle pallet tests were conducted in the large scale fire test facility which consists of a 120 x 120 ft. fire test cell which is equipped with a 100 x 100 ft. adjustable height ceiling. The height of the ceiling may be adjusted by 4 hydraulic rams up to a maximum height of 48 feet. The ceiling has a load capacity of 250 tons. A flexible design sprinkler piping is available at the ceiling to permit any arrangement of sprinkler spacing with minimum pressure losses. Further, the sprinkler deflector can be adjusted to be a specified distance from the ceiling.

The floor of the test facility is 100 ft. by 100 ft. is smooth and flat and is surrounded with a grated drainage to insure adequate floor water drainage from the test area.

2.2 Heat Release Calorimeter Facility

The heat release calorimeter is housed in a nominal 50 x 50 ft. fire test cell equipped with a 25 ft. diameter collection hood.

The floor of the test facility is 30 x 30 ft. is smooth and flat and is surrounded with a grated drainage to insure adequate floor water drainage from the test area.

3. EQUIPMENT

3.1 Idle Pallet Storage Tests

The idle pallet storage tests were conducted in the Large-Scale Test Facility.

3.1.1 Sprinkler System

A wet pipe automatic sprinkler system was positioned below the adjustable smooth flat non-combustible ceiling and pressure controlled to provide the required water discharge density. The upright sprinklers were supplied through looped piping system consisting of 2 in. pipe. The piping system was supplied by a variable speed pump capable of supplying an adequate pressure and flow to maintain the required water discharge density. The sprinklers were installed on a 10 x 10 ft. spacing.

A description of the sprinklers used in each test is provided below:

Table 3. Sprinkler System

Test No.	Design Density gpm/ft²	Activation Temperature (°F)	Orifice Coeficient gpm/(psi)$^{1/2}$	Sensitivity
1	0.3	286	K=8	Standard
2	0.3	286	K=8	Standard
3	0.6	286	K=8	Standard
4	0.3	286	K=8	Standard
5	0.6	286	K=8	Standard
6	0.6	165	K=11	Standard

Sprinkler activation was determined by a 25°C temperature drop in one second measured by thermocouples positioned one inch from the sprinklers.

A schematic of the sprinkler layout is shown in Figure 2.

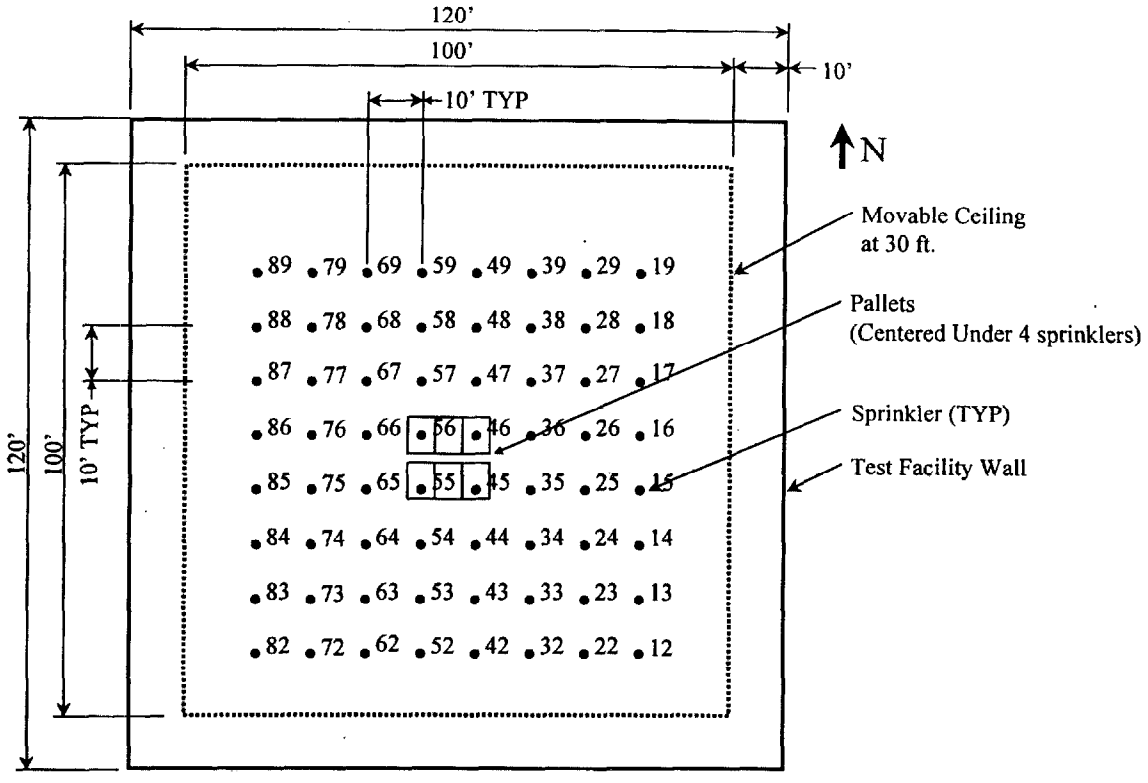


Figure 2. Reflected Plan View : Test Set-Up

3.1.2 Air Temperature Near Sprinklers

The air temperature one inch from the element of each sprinkler was measured with a 0.0625 inch diameter inconel sheathed Type K thermocouple. The thermocouples were numbered as shown in Figure 2.

3.1.3 Steel Beam Temperature

A 4 ft. long 2 by 2 inch steel angle was mounted below the ceiling directly above the center of the pallet array. The temperature of the steel beam was measured with five Type K thermocouples welded to the beam.

3.1.4 Radiant Heat Flux

Four total heat flux gages of the Schmidt-Boelter type were positioned such that they viewed the center of each side of the pallet array. The heat flux gages were mounted 24 inches above the floor 8 ft. from the array. The heat flux gages had 180° view angles.

3.1.5 Video

Two VHS video cameras were used to record each test.

3.1.6 Data Collection

All data was collected using an electronic data acquisition system at a one second scan rate.

3.1.7 Igniters

Four igniters were used in each test. The igniters were constructed from a 3 inch diameter by 6 inch long cellulosic bundle soaked with 8 fluid ounces of gasoline and wrapped in a polyethylene bag.

3.2 Commodity Classification Tests

The commodity classification tests were conducted in the Heat Release Rate Calorimeter Facility.

3.2.1 Calorimeter

The calorimeter consists of a 25 foot diameter collection hood connected to an exhaust system capable of 60,000 CFM.

The heat release calorimeter is equipped with convective and total heat release instrumentation. The convective instrumentation calculates the heat release rate from the energy rise of the products of combustion entering the calorimeter. The total heat release instrumentation calculates fire size using oxygen consumption techniques.

3.2.2 Water Applicator

The water applicator has been designed to provide a uniform water density up to 2 gpm/ft^2 onto the top surface of the commodities. The applicator consists of four parallel double-walled steel pipes with four spray nozzles along each pipe. The double walled construction allows cooling water to flow along the outside, and the suppression water to flow on the inside. The water applicator is typically mounted 12 inches above the commodity to provide a uniform coverage over an 8 x 8 ft. area.

3.2.3 Video

One VHS video camera was used to record each test.

3.2.4 Data Collection

All data was collected using an electronic data acquisition system at a two second scan rate.

3.2.5 Igniters

Four igniters were used in each test. The igniters were constructed from a 3 inch diameter by 3 inch long cellulosic bundle soaked with 4 fluid ounces of gasoline and wrapped in a polyethylene bag.

4. SAMPLES

The 2-way pallets were constructed from oak. The outside dimensions of the pallets were 42 x 42 x 4.6 inches. They were constructed with 0.5 inch thick boards on the top and bottom. Three 1.4 x 3.5 inch boards were used in the center.

The 4-way pallets were constructed from southern yellow pine with hardwood boards at the outsides for strength. The outside dimensions of the pallets were 40 x 48 x 6.75 inches. The pallets were constructed with nine 3.25 inch high block in the center. The blocks marked 'A' in Figure 3 were 7.5 x 5 x 3.25 inches. The blocks labeled 'B' were 3.75 x 5 x 3.25 inches. The top and bottom boards were 0.6 inches thick.

A Plan view of the two types of pallets are shown in Figure 3.

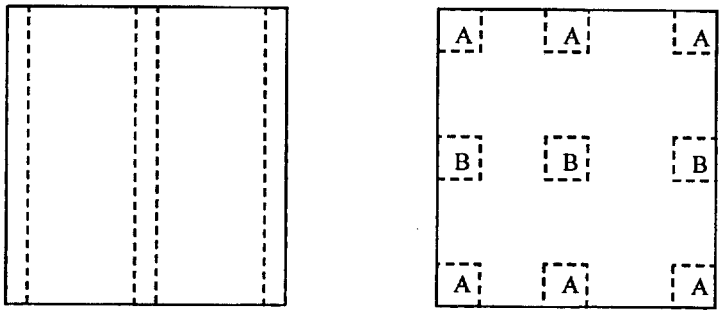


Figure 3. Pallets

5. TEST METHOD

5.1 Idle Pallet Tests

The idle pallet tests consisted of placing an array of wood pallet stacks below a 30 ft. ceiling equipped with a sprinkler system. The pallets were ignited in the center of the array and the effectiveness of the sprinkler system was observed. Measurements during the tests included: (i) number of operated sprinklers, (ii) steel beam temperatures above the fire, and (iii) radiant heat fluxes. The flame spread through the pallet array was also recorded.

Two storage arrangements were used in this investigation as shown in Figure 1. Test 1 was conducted with a 2x2 array. Test 2 through 6 tests were conducted with a 2x3 array. The 2x2 array was used only once because the array was not large enough to evaluate flame spread.

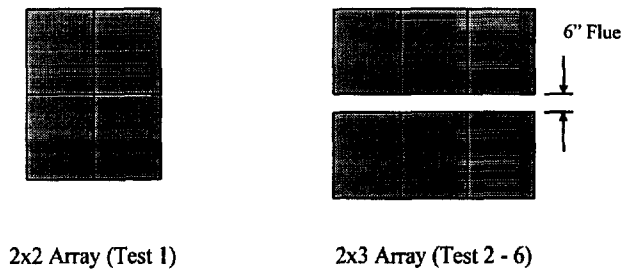


Figure 4. Plan View of Test Layout

The test set-up for test 2-6 is shown in Figure 5.

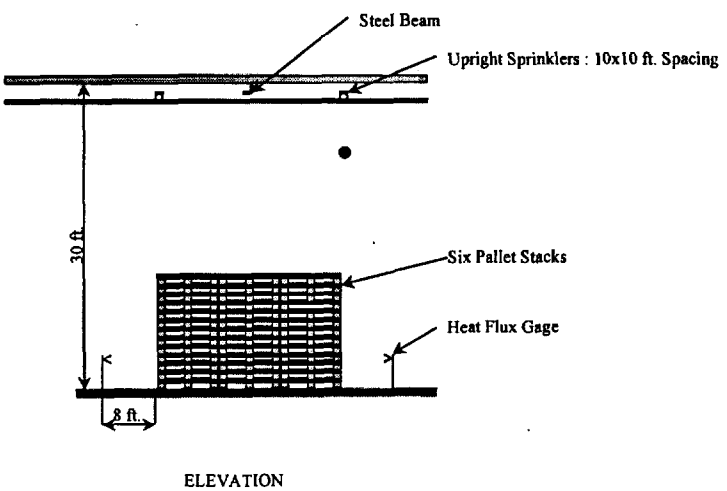


Figure 5. Idle Storage Test Set-Up (Test 2-6)

5.2 Commodity Classification Tests

The tests were conducted in general accordance with the method defined in "*SP Report 1993:70 Commodity Classification - A more Objective and Applicable Methodology*".

Eight pallets of Class II Commodity on pallets were placed in a 2 by 2 by 2 rack storage array below the heat release calorimeter. The commodities were ignited in the center flue space, and when the fire attained a sufficient size, water application was initiated. Heat release rate of the fire was measured throughout each test.

The set-up is shown in Figure 6.

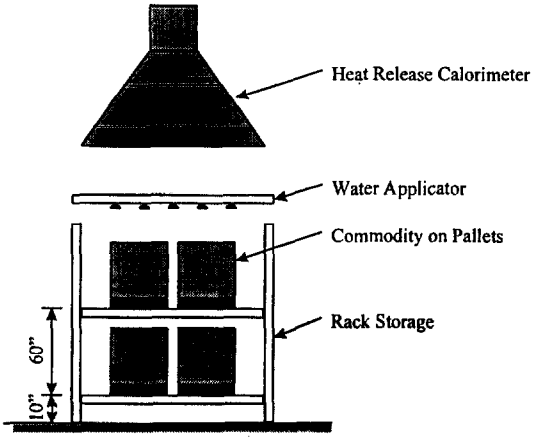


Figure 6. Test Set-up

The water activation time was calculated using a sprinkler activation model developed at Underwriters Laboratories. The algorithm was integrated into the heat release calorimeter's data acquisition program. The algorithm used the input parameters shown in Table 4 and the convective heat release rate calculated during the test.

Table 4. Sprinkler Activation Algorithm Inputs

Description	Value
Sprinkler Activation Temperature	286°F
Sprinkler RTI	500 $(ft \cdot sec)^{1/2}$
Distance of detector element below ceiling	7 inches
Radial distance of sprinkler to center of fire	7.1 ft. (10 x10 ft. sprinkler spacing)
Distance of ceiling to top of commodity	10 ft.
Number of storage tiers	2

6. RESULTS AND DISCUSSION

6.1 Idle Pallet Tests

6.1.1 Summary

Test parameters and results are summarized in Table 5. Appendix A provides tables of the activation times for the sprinklers in each test. Appendix B proxides tables of the maximum temperature at each sprinkler location.

Table 5. Idle Pallet tests

Test	Array	Sprinkler	Activated Sprinklers	Maximum Steel Temp. [1] (°C)	Max Heat Flux (kW/m²)	Fire spread To end of array	Test Code
1	2-way, 2x2, 8ft.	286°F, K8, 0.3 gpm/ft²	7	170	[3]	Yes	01199807
2	4-way, 2x3, 8ft.	286°F, K8 0.3 gpm/ft²	40 [2]	725 [2]	21 [2]	Yes	01209804
3	4-way, 2x3, 12 ft.	286°F, K8 0.6 gpm/ft²	10	658	19	Yes	01209805
4	2-way, 2x3, 8 ft.	286°F, K8 0.3 gpm/ft²	8	148	12	No	01219803
5	2-way, 2x3, 12 ft.	286°F, K8 0.6 gpm/ft²	7	157	14	No	01219804
6	4-way, 2x3, 12 ft.	165°F, K11 0.6 gpm/ft²	13	94	9	Yes	01229802

Note:

4. The maximum steel temperature is an average of the five temperatures measured on the beam.
5. The fire was still growing when the test was manually terminated.
6. The heat flux was not measured in test 1.

6.1.2 Dammage Assessment

Figure 7 shows the extent of flame in each idle pallet test. The grey shading in the Figure indicates the areas of the pallets that were charred.

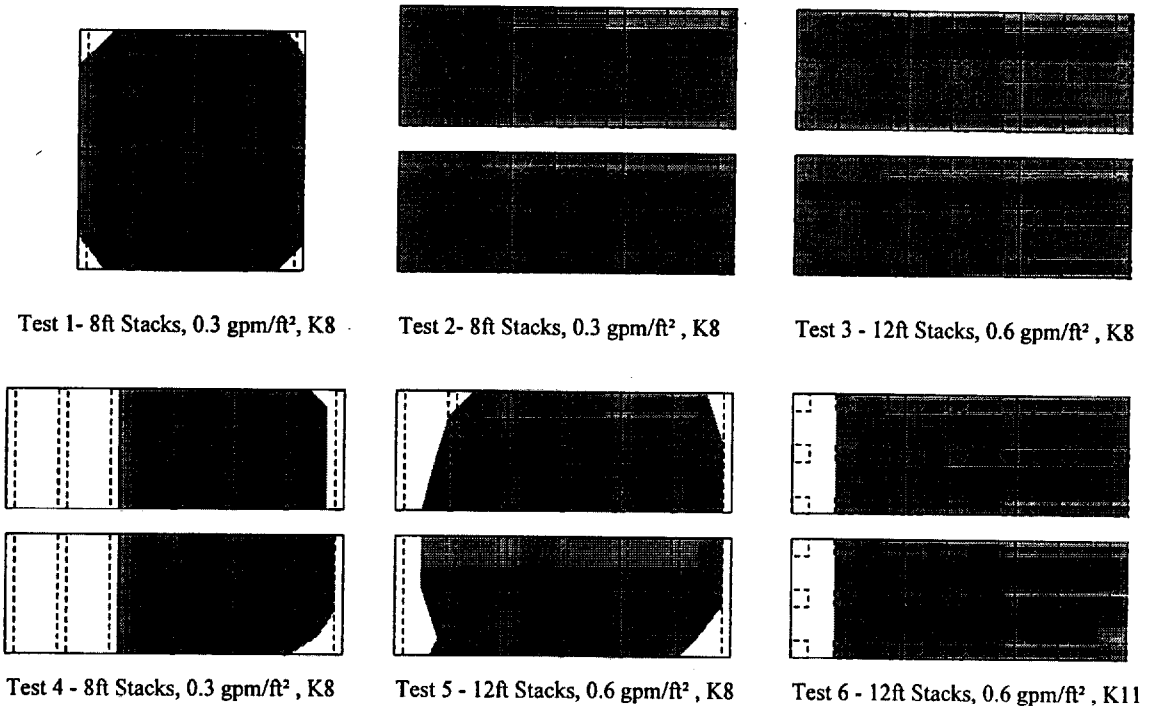


Figure 7. Dammage Assessment

6.2 Commodity Classification Tests

The test parameters are summaraized in Table 6.

Table 6. Commodity Classification Tests

Test	Commodity	Delivered Water Density (gpm/ft²)
1	Class II on 2-Way Hardwood Pallets	0.11
2	Class II on 2-Way Hardwood Pallets	0.21
3	Class II on 2-Way Hardwood Pallets	0.31
4	Class II on 4-Way Pine Pallets	0.11
5	Class II on 4-Way Pine Pallets	0.21
6	Class II on 4-Way Pine Pallets	0.31

The graphs of total chemical heat release rate and convective heat release rate are provided in Figure 8 through Figure 11 respectively.

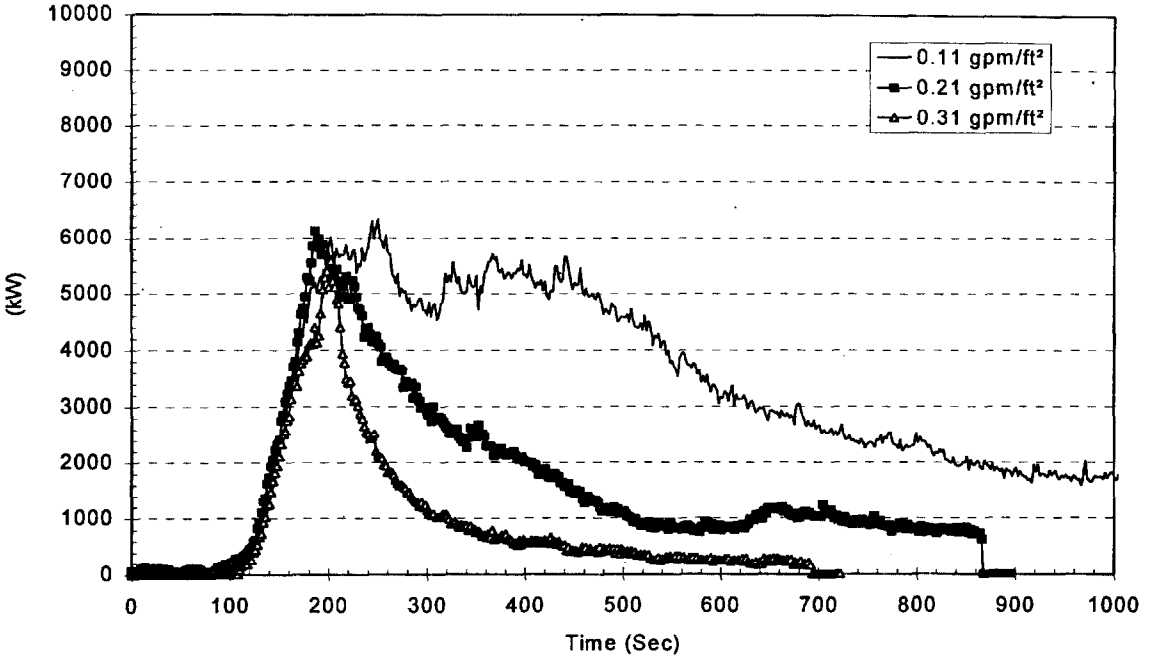


Figure 8. Total Heat Release Rate : 2-Way Pallets

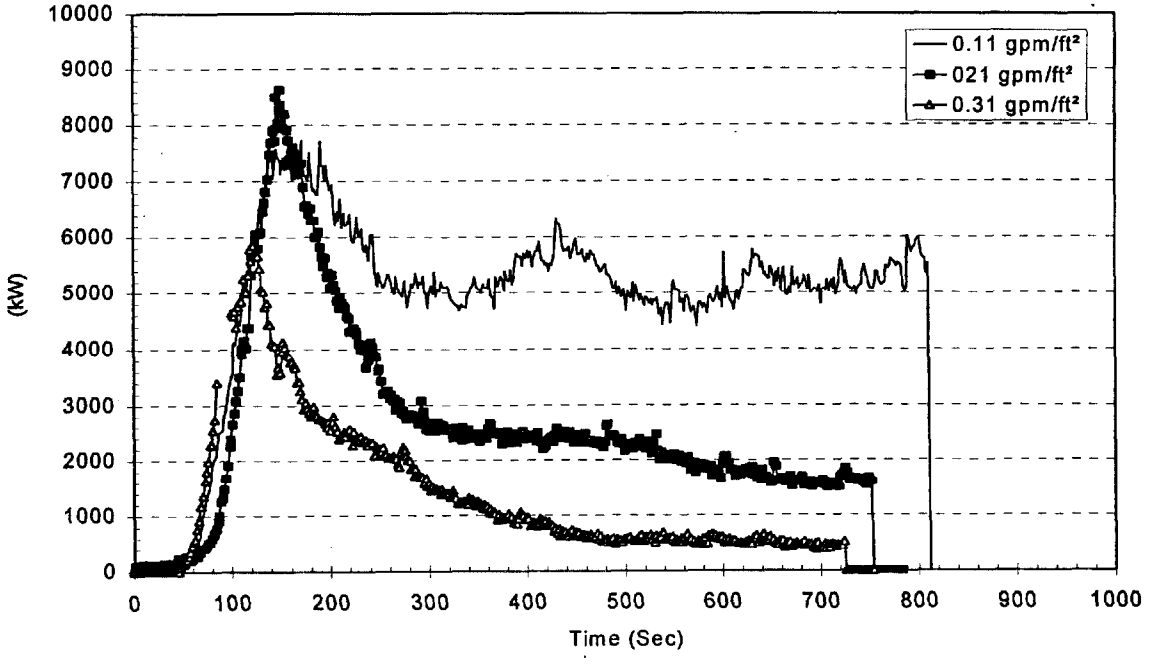


Figure 9. Total Heat Release Rate : 4 - Way Pallets

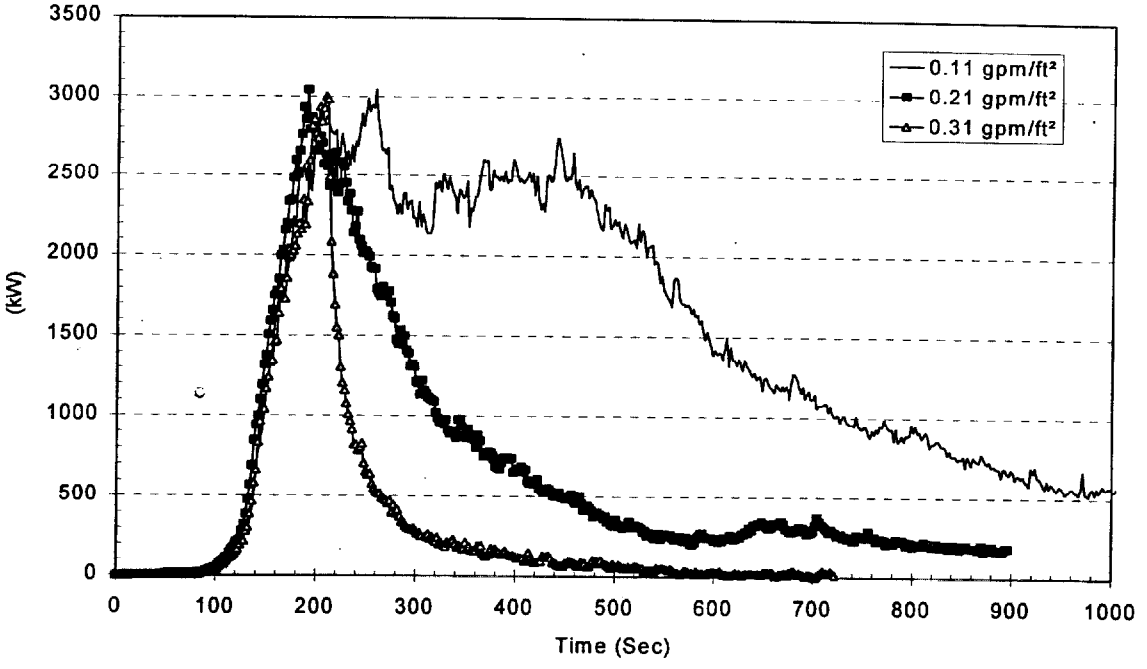


Figure 10. Convective Heat Release Rate : 2-Way Pallets

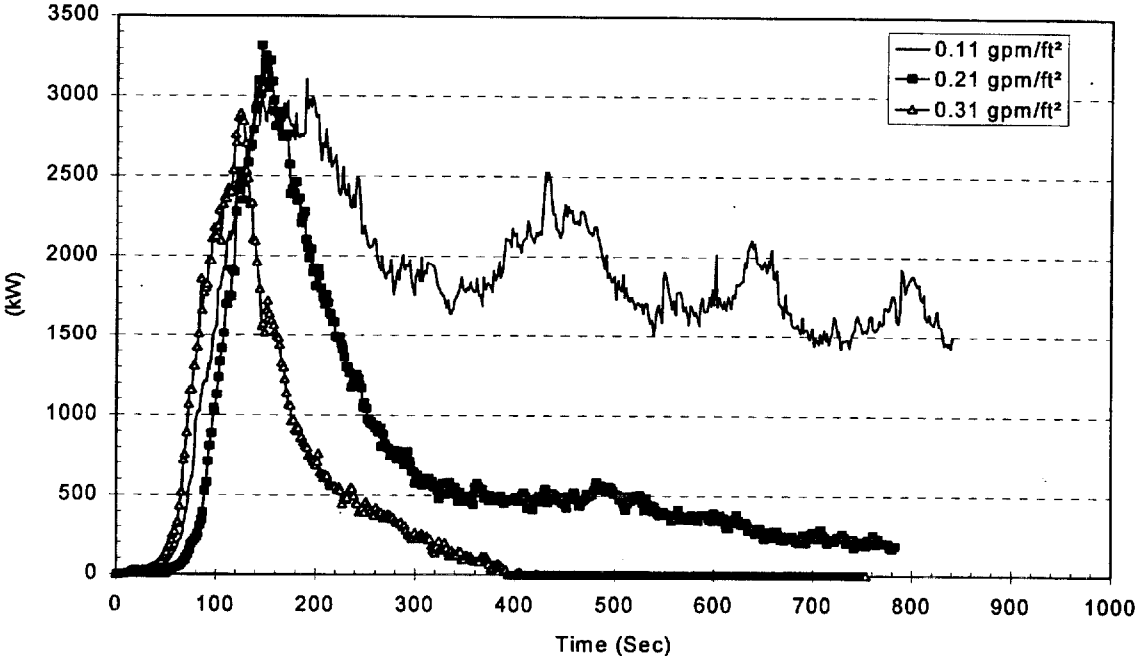


Figure 11. Convective Heat Release Rate : 4-Way Pallets

In order to determine the classification of commodities an objective ranking system has been developed. The product ranks range from 1 to 7 in increasing order of fire hazard.

Table 7. Commodity Classification

Commodity Class	Product Rank	Standard commodity used as reference
I	1.0	Glass jars in compartmented cartons
II	2.0	Double tri-wall cartons with steel liner
III	3.0	Paper jars in compartmented cartons
IV	4.0	Polystyrene and paper jars in compartmented cartons.
Cartonated Group B Unexpanded Plastics	5.0	
Cartonated Group A Unexpanded Plastics	6.0	Polystyrene jars in compartmented cartons
Cartonated Group A Expanded Plastics	7.0	
Extra Hazard	Ex	

The product rank is determined from the heat release rate results. The product rank is based upon four parameters calculated from the convective and total heat release rate measured from the burning commodities. These four parameters are defined as follows:

V1 Maximum one minute average of the total heat release rate.
V2 Maximum one minute average of the convective heat release rate.
V3 Effective convective heat release rate, defined as the average convective heat release rate measured over the five minutes of the most intense fire.
V4 Convective Energy, the total convective energy measured over the ten minutes of most severe burning.

Commodities that have a product rank greater than 7 are classified an extra hazard, Ex, commodity. There are no generic protection guidelines for these commodities, and large scale fire testing is required to develop sprinkler protection guidelines for these products.

Table 8. Results Summary

Test	Pallet Type	Delivered Water Density (gpm/ft²)	V1 (kW)	V2 (kW)	V3 (kW)	V4 (kW)	Rank [1]	Average Rank	Commodity Classification
1	2-Way	0.11	5808	2787	2510	2020	2.0	1.7	Class II
2		0.21	5320	2618	1480	900	1.8		
3		0.31	4258	2277	798	423	1.4		
4	4-Way	0.11	7248	2874	2249	2061	2.0	2.1	Class II
5		0.21	7174	2774	1369	887	2.1		
6		0.31	6030	2277	935	476	2.1		

Note [1] - Rank determined using tables provided in SP1993:70

Appendix A

Sprinkler Activation Times

Test Code = 01199807 **Activation Times (sec)**

Sprinkler 82..89								
Sprinkler 72..79								
Sprinkler 62..69				1422				
Sprinkler 52..59				967	1112			
Sprinkler 42..49				1046	1108			
Sprinkler 32..39				1471	1656			
Sprinkler 22..29								
Sprinkler 12..19								

Test Code = 01209804 **Activation Times (sec)**

Sprinkler 82..89				793				
Sprinkler 72..79			655	591	610	753		
Sprinkler 62..69		640	629	424	474	541	672	
Sprinkler 52..59	698	638	427	300	267	386	498	650
Sprinkler 42..49		541	420	271	287	487	565	748
Sprinkler 32..39		778	504	367	449	555	713	
Sprinkler 22..29			518	497	539	565		
Sprinkler 12..19				645	665			

Test Code = 01209805 **Activation Times (sec)**

Sprinkler 82..89								
Sprinkler 72..79				780	774			
Sprinkler 62..69					487			
Sprinkler 52..59			801	349	407			
Sprinkler 42..49				346	405			
Sprinkler 32..39								
Sprinkler 22..29				754	642			
Sprinkler 12..19								

Test Code = 01219804 **Activation Times (sec)**

Sprinkler 82..89								
Sprinkler 72..79								
Sprinkler 62..69			1367	1161				
Sprinkler 52..59			1384	715	687			
Sprinkler 42..49					707			
Sprinkler 32..39					1086			
Sprinkler 22..29								
Sprinkler 12..19								

Test Code = 01219803 **Activation Times (sec)**

Sprinkler 82..89								
Sprinkler 72..79								
Sprinkler 62..69					1226			
Sprinkler 52..59				1078	919			
Sprinkler 42..49			1608	915	1030			
Sprinkler 32..39				1235	1430			
Sprinkler 22..29								
Sprinkler 12..19								

Test Code = 01229802 **Activation Times (sec)**

Sprinkler 82..89								
Sprinkler 72..79								
Sprinkler 62..69				855	679	709		
Sprinkler 52..59				215	184	962		
Sprinkler 42..49		1373		187	190			
Sprinkler 32..39			995	584				
Sprinkler 22..29				806	820			
Sprinkler 12..19								

Appendix B

Maximum Temperatures

Test Code = 01199807 **Maximum Temperatures (°F)**

Sprinkler 82..89	228	240	262	284	282	260	226	212
Sprinkler 72..79	244	248	269	314	302	262	228	226
Sprinkler 62..69	240	264	287	338	327	244	246	248
Sprinkler 52..59	233	264	303	363	381	321	293	258
Sprinkler 42..49	239	289	309	352	363	330	300	273
Sprinkler 32..39	239	260	262	349	386	264	264	253
Sprinkler 22..29	233	233	257	329	314	278	240	240
Sprinkler 12..19	224	237	266	291	294	266	240	228

Test Code = 01209804 **Maximum Temperatures (°F)**

Sprinkler 82..89	300	318	356	368	354	327	320	289
Sprinkler 72..79	321	377	384	380	346	395	357	291
Sprinkler 62..69	366	398	385	378	367	365	351	314
Sprinkler 52..59	371	389	369	390	401	396	373	362
Sprinkler 42..49	336	383	363	376	376	396	378	355
Sprinkler 32..39	300	375	398	374	401	416	366	312
Sprinkler 22..29	298	347	355	378	387	389	316	296
Sprinkler 12..19	285	314	348	378	375	336	312	280

Test Code = 01209805 **Maximum Temperatures (°F)**

Sprinkler 82..89	210	230	282	314	339	264	206	195
Sprinkler 72..79	212	230	309	388	380	213	213	212
Sprinkler 62..69	240	237	233	529	394	204	233	235
Sprinkler 52..59	260	302	272	387	358	248	302	258
Sprinkler 42..49	287	334	240	394	398	452	318	276
Sprinkler 32..39	255	253	262	675	455	208	291	248
Sprinkler 22..29	230	240	309	414	396	240	249	255
Sprinkler 12..19	224	248	296	344	316	264	221	233

Test Code = 01219804 **Maximum Temperatures (°F)**

Sprinkler 82..89	239	240	249	251	233	197	188	194
Sprinkler 72..79	242	278	294	286	276	213	213	206
Sprinkler 62..69	233	271	361	359	275	239	226	230
Sprinkler 52..59	199	231	307	729	368	219	267	235
Sprinkler 42..49	179	190	204	355	710	379	287	244
Sprinkler 32..39	176	192	217	366	370	336	291	235
Sprinkler 22..29	177	192	230	359	280	289	262	251
Sprinkler 12..19	183	212	248	278	244	242	240	233

Test Code = 01219803 **Maximum Temperatures (°F)**

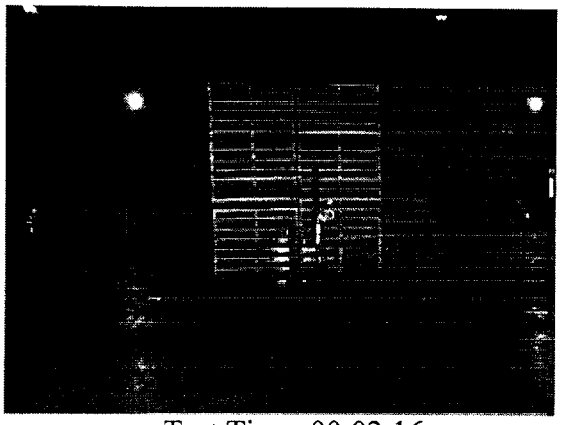
Sprinkler 82..89	230	230	248	273	276	260	242	224
Sprinkler 72..79	240	244	246	300	307	269	244	235
Sprinkler 62..69	251	266	273	334	334	273	255	239
Sprinkler 52..59	246	294	348	379	354	338	266	228
Sprinkler 42..49	264	307	354	354	341	339	273	242
Sprinkler 32..39	239	255	240	341	356	273	273	230
Sprinkler 22..29	224	226	233	285	305	280	251	244
Sprinkler 12..19	208	221	240	269	266	255	246	226

Test Code = 01229802 **Maximum Temperatures (°F)**

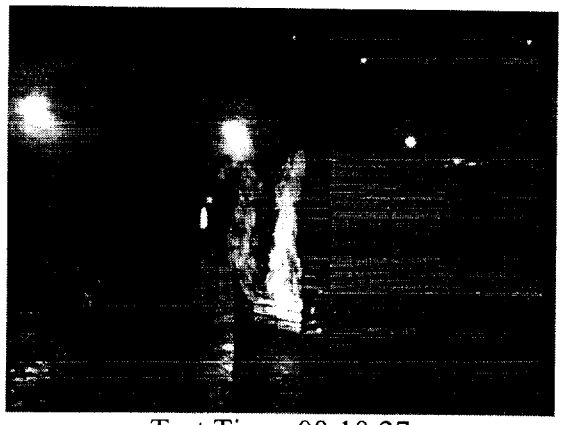
Sprinkler 82..89	165	154	174	176	165	165	159	161
Sprinkler 72..79	176	176	185	194	181	186	176	165
Sprinkler 62..69	174	190	206	227	207	213	188	170
Sprinkler 52..59	170	201	217	259	244	228	183	154
Sprinkler 42..49	177	221	235	246	246	222	167	152
Sprinkler 32..39	165	195	231	225	240	208	179	158
Sprinkler 22..29	177	190	186	209	184	213	181	165
Sprinkler 12..19	161	185	185	185	194	183	154	163

Appendix C

Pictures of Idle Pallet Tests



Test Time 00:02:16



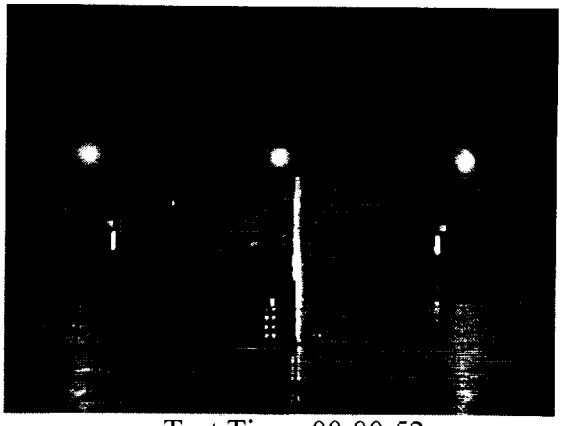
Test Time 00:10:27

Test Time 00:13:04

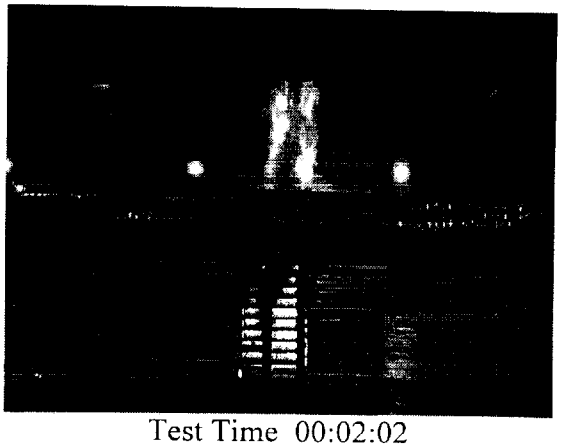
Test Time 00:14:15

Test Time 00:14:43

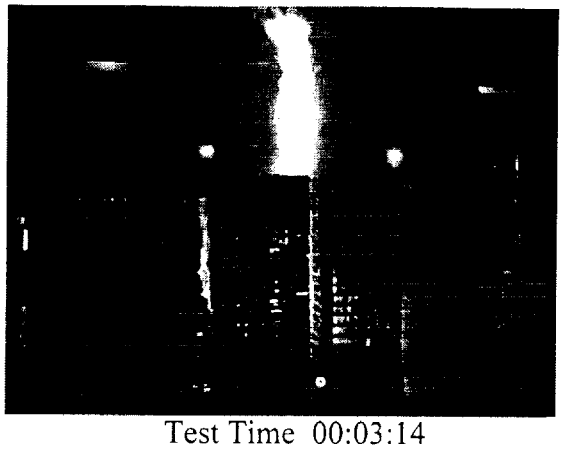
Figure 12. Pictures : Test 1



Test Time 00:00:52

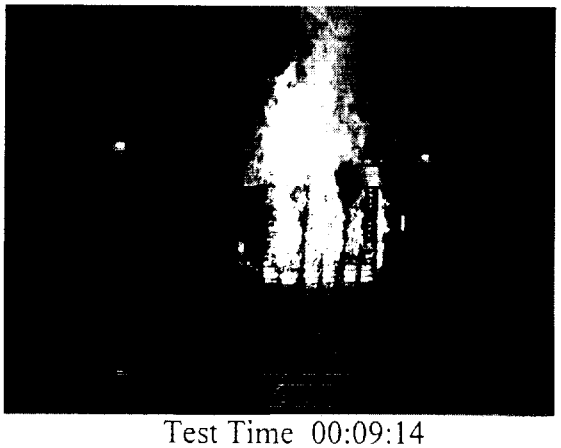


Test Time 00:02:02

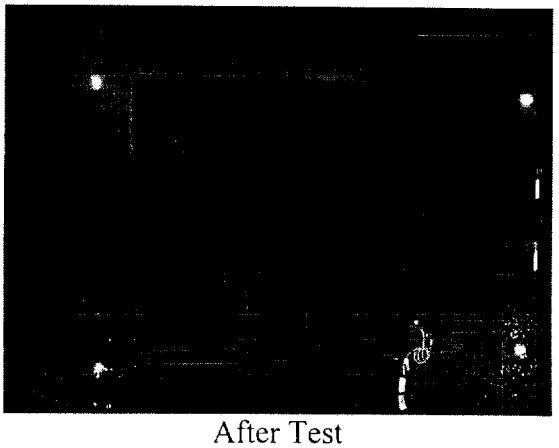


Test Time 00:03:14

Test Time 00:05:08



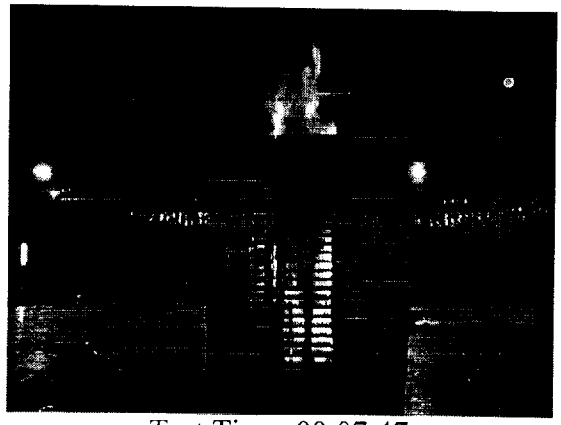
Test Time 00:09:14



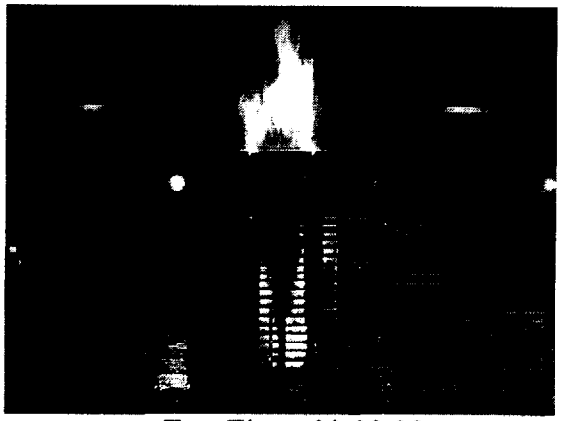
After Test

Figure 13. Pictures : Test 2

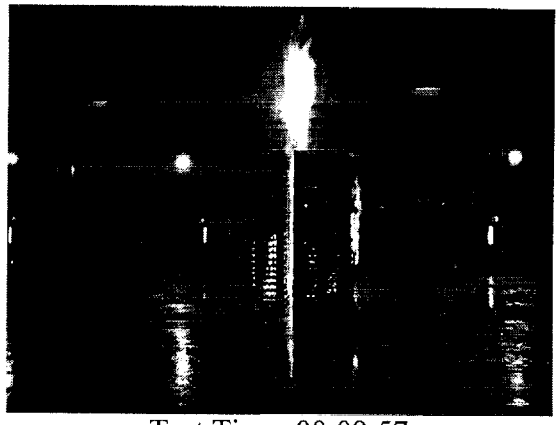
Test Time 00:06:50



Test Time 00:07:47

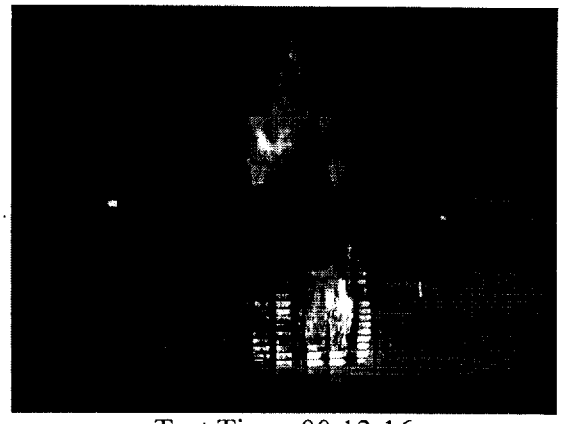


Test Time 00:08:38



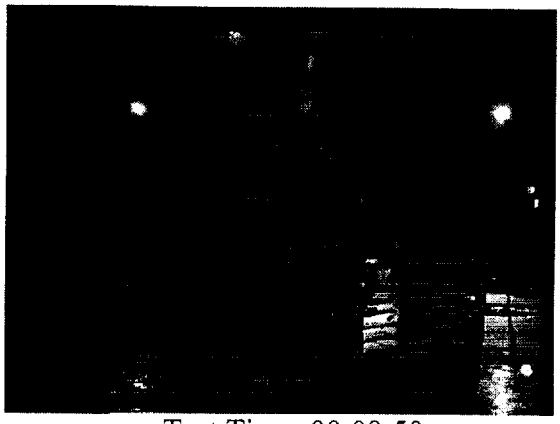
Test Time 00:09:57

Test Time 00:11:11



Test Time 00:12:16

Figure 14. Pictures: Test 3

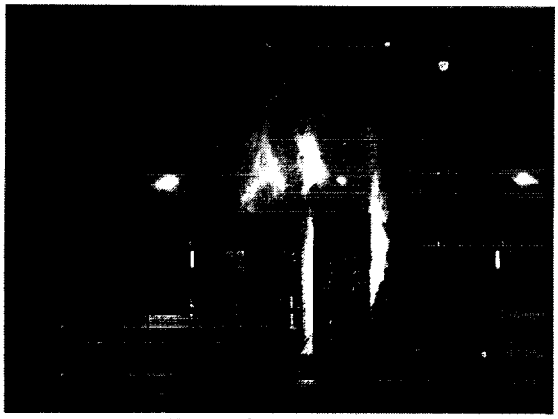


Test Time 00:09:50

Test Time 00:12:35

Test Time 00:15:38

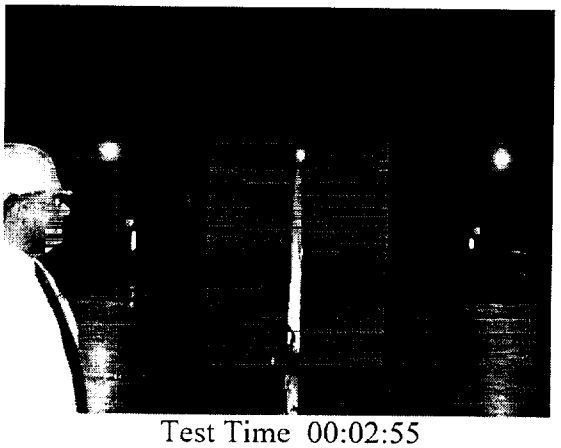
Test Time 00:18:04



Test Time 00:20:35

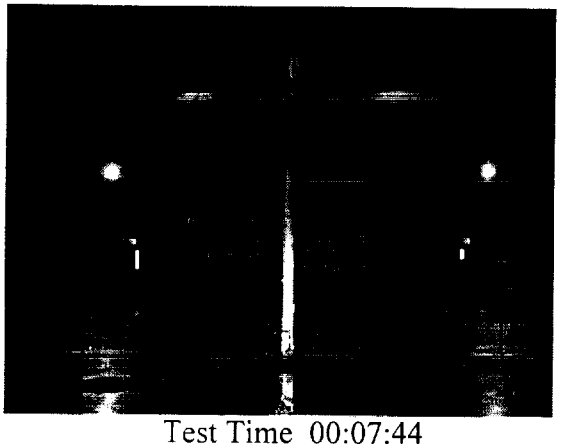
Test Time 00:26:17

Figure 15. Pictures: Test 4

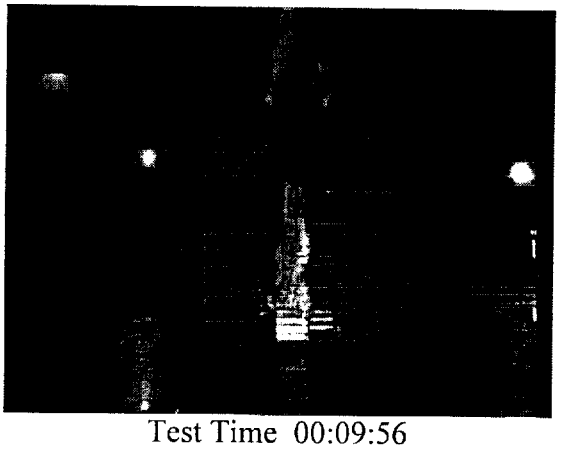


Test Time 00:02:55

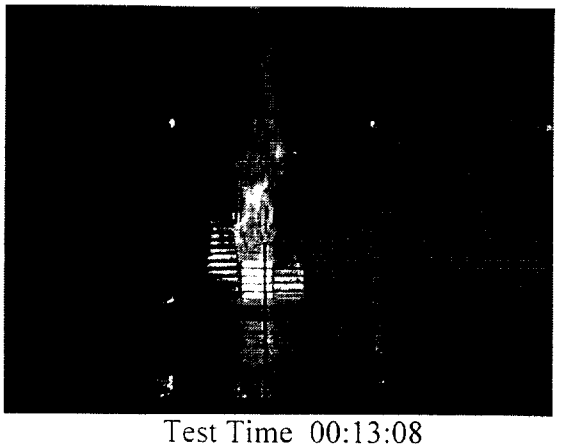
Test Time 00:04:08



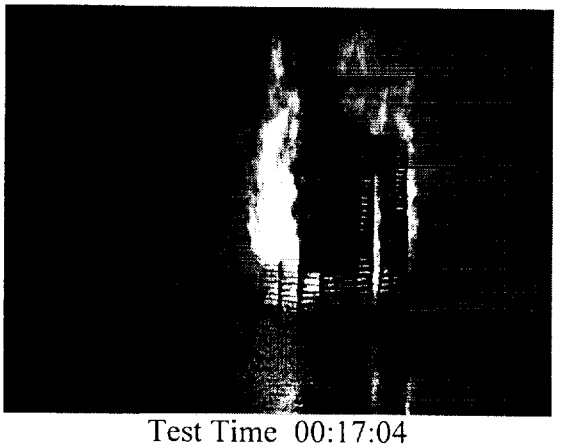
Test Time 00:07:44



Test Time 00:09:56

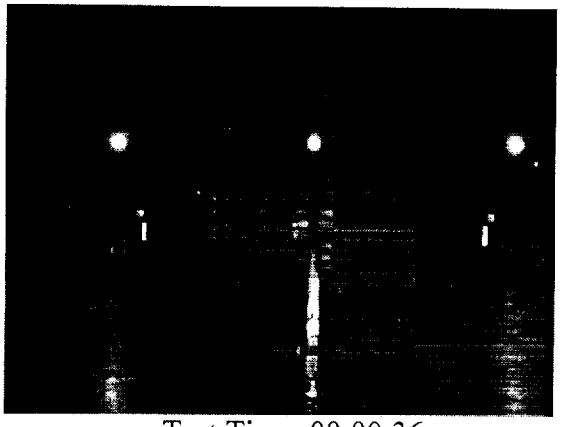


Test Time 00:13:08

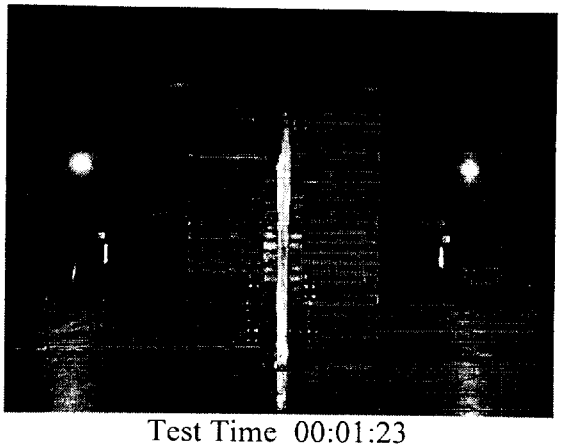


Test Time 00:17:04

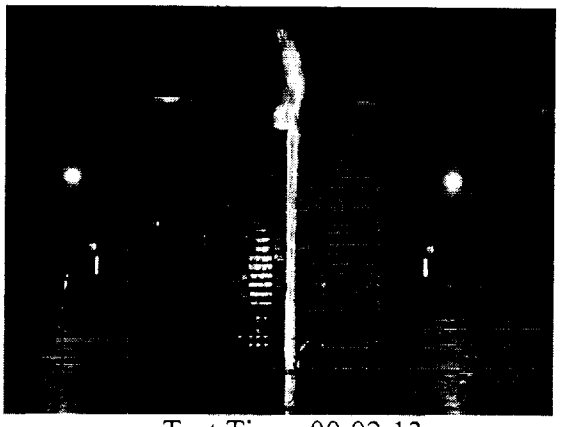
Figure 16. Pictures: Test 5



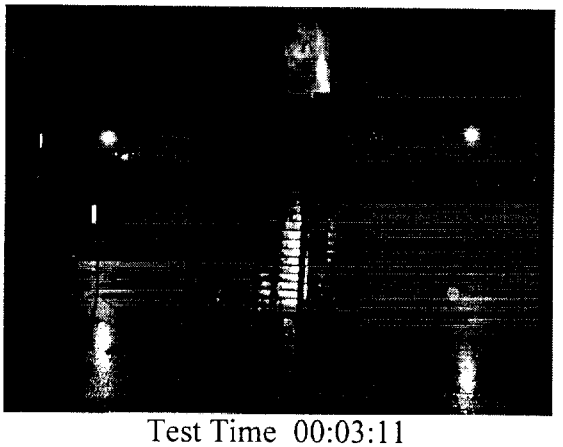
Test Time 00:00:36



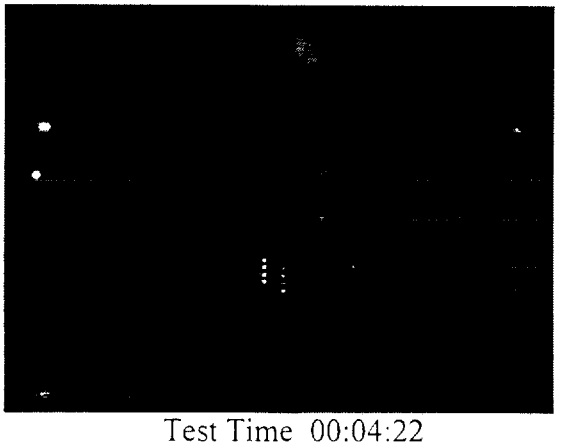
Test Time 00:01:23



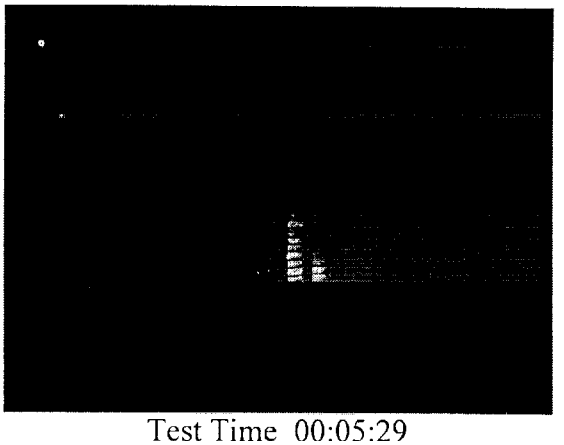
Test Time 00:02:13



Test Time 00:03:11



Test Time 00:04:22



Test Time 00:05:29

Figure 17. Pictures : Test 6

Appendix D

Idle Pallet Heat Flux Measurements

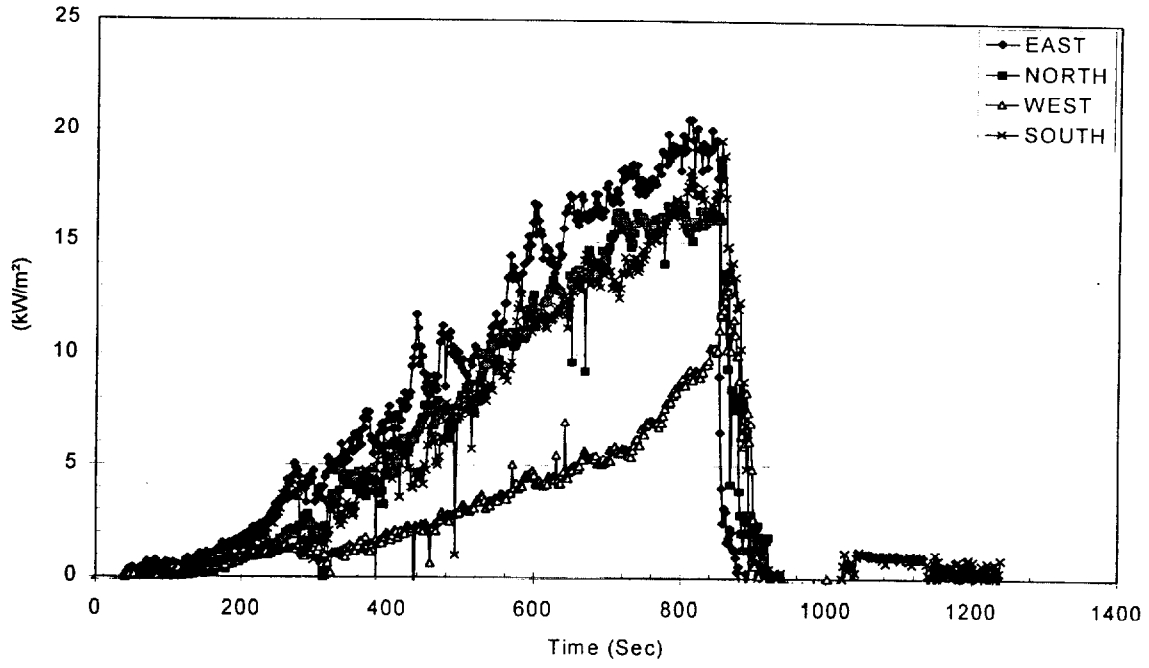


Figure 18. Test 2

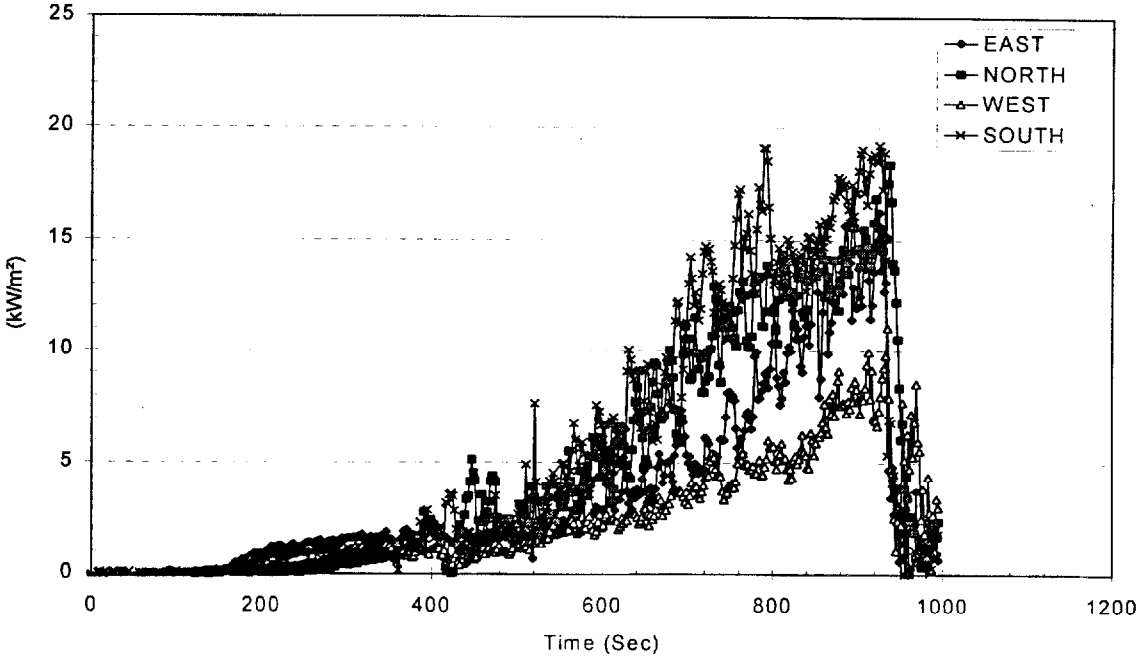


Figure 19. Test 3

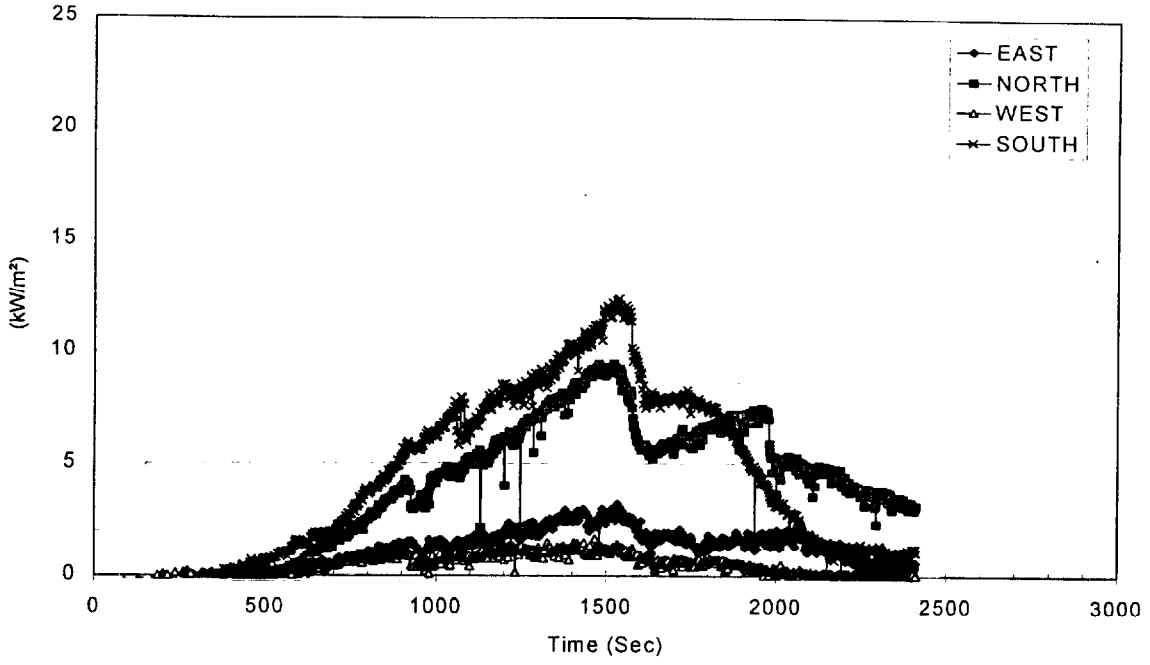


Figure 20. Test 4

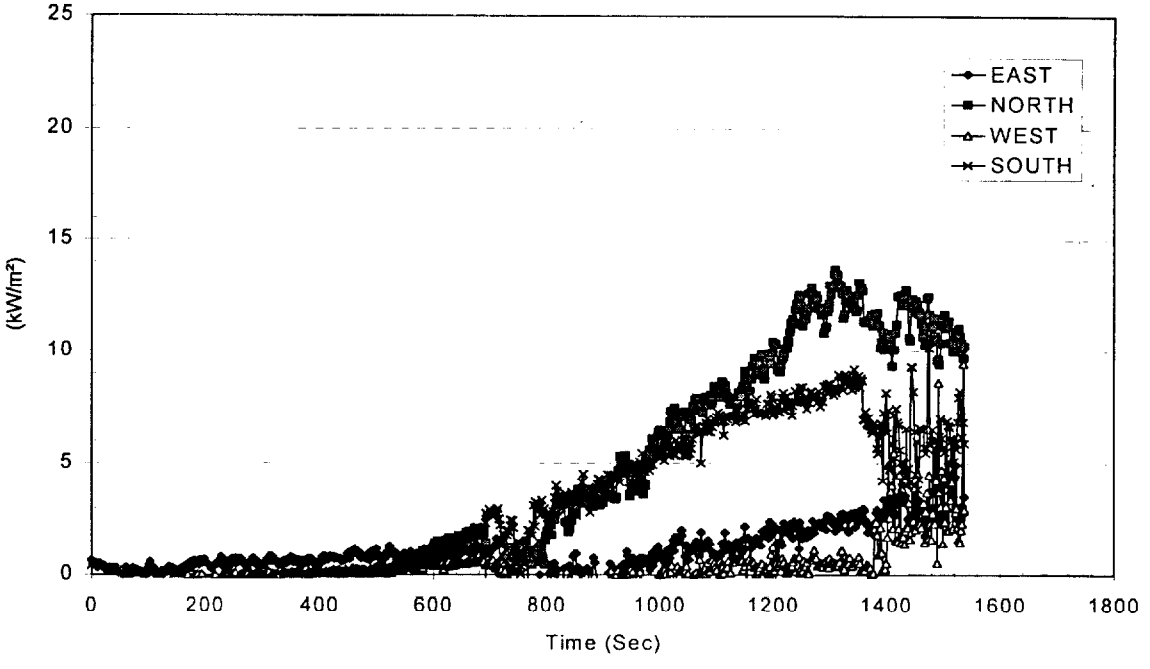


Figure 21. Test 5

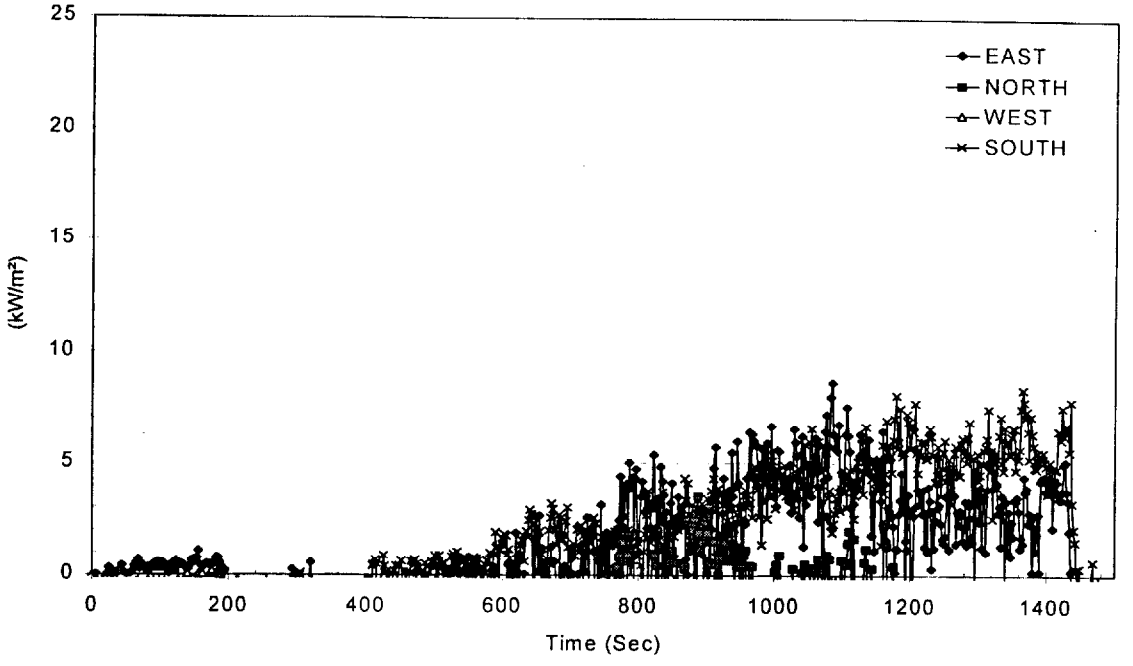


Figure 22. Test 6